National Institute of Environmental Health Sciences

Assessing the impact of weather events at mid-latitudes on the atmospheric transport of chemical pollutants using a 2-dimensional multimedia meteorological model

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Abstract:

We investigate the long-range transport potential (LRTP) of five different classes of hypothetical chemical pollutants (volatile, multimedia, semivolatile, particle-associated and hydrophilic) during a low pressure weather event using a novel 2 (x- and z-axis)-Dimensional Multi-Media Meteorological Model (2D4M). The atmosphere (z-axis) is described by three atmospheric layers, where two layers constitute the boundary layer and the third layer the free troposphere. The 2D4M can describe distinct weather events on a regional scale and calculate the LRTP of chemicals as a function of time during these events. Four weather factors are used to model weather events and their influence on the atmospheric transport of chemicals: (1) temperature, (2) wind speed and mixing dynamics of the troposphere, (3) hydroxyl radical concentrations and (4) precipitation. We have modeled the impact of variability in each of these factors on LRTP of pollutants during a front event associated with a low pressure period that interrupts a dominant high pressure system. The physico-chemical properties of the pollutant determine which specific weather factors contribute most to variability in transport potential during the event. Volatile and multimedia chemicals are mainly affected by changing atmospheric mixing conditions, wind speeds and OH radical concentrations, while semivolatile substances are also affected by temperature. Low-vapor-pressure pollutants that are particle-associated, and water-soluble pollutants are most strongly affected by precipitation. Some chemical pollutants are efficiently transported from the boundary layer into the upper troposphere during the modeled low pressure event and are transported by much higher wind speeds than in the boundary layer. Our model experiments show that the transport potential of volatile, multimedia and semivolatile compounds is significantly increased during a front event as a result of efficient tropospheric mixing and fast wind speeds in the upper troposphere, whereas low-volatility and hydrophilic chemicals are largely scavenged from the atmosphere. In future LRTP assessment of chemical contaminants as required by the Stockholm Convention and the convention on long-range transboundary air pollution, it is therefore advised to prioritize volatile, multimedia and semivolatile chemicals that are identified in initial screening. © 2010 Elsevier Ltd.

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Resource Description

Communication: ☒

resource focus on research or methods on how to communicate or frame issues on climate change; surveys of attitudes, knowledge, beliefs about climate change

A focus of content

Communication Audience:

audience to whom the resource is directed

Researcher

Early Warning System:

resource focus on systems used to warn populations of high temperatures, extreme weather, or other elements of climate change to prevent harm to health

A focus of content

Exposure :

weather or climate related pathway by which climate change affects health

Extreme Weather Event, Other Exposure

Geographic Feature:

resource focuses on specific type of geography

None or Unspecified

Geographic Location:

resource focuses on specific location

Global or Unspecified

Health Impact:

specification of health effect or disease related to climate change exposure

General Health Impact

Intervention:

strategy to prepare for or reduce the impact of climate change on health

A focus of content

Mitigation/Adaptation:

mitigation or adaptation strategy is a focus of resource

Adaptation

Model/Methodology:

type of model used or methodology development is a focus of resource

Exposure Change Prediction

Resource Type:

format or standard characteristic of resource

Research Article

Timescale: ☒

time period studied

Short-Term (

Vulnerability/Impact Assessment: ☒

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content